Cupgrass - Seedling resembles broadleaf signalgrass; however, the seedling is smooth (2-to 3-leaf stage) and is not distinctly velvety in texture as is broadleaf signalgrass. The leaves are not short and broad as signalgrass but long and comparable to johnsongrass.

◆ Red Rice

Red rice has been a weed problem in the rice growing area for a number of years. Recently, as rice acreage has expanded in Mississippi, red rice has become an even more serious weed problem.

Botanically, red rice is the same species as cultivated rice, *Oryza sativa* (L.). It is actually a variety of rice. It reproduces itself and does not come from rice varieties genetically "running out." Red rice is difficult to control in rice and is a strong competitor, thereby reducing yields. Yield is reduced in proportion to the infestation. An extremely heavy infestation of red rice can reduce yields nearly 100 percent.

Red rice plants vary considerably. The tall-growing, black-hulled, awned plant is easiest to recognize and is considered by many to be a typical red rice plant. However, other types have developed that have straw-colored hulls, are awnless, and are about the same height as desirable rice varieties. This type of red rice is the most prevalent kind in Mississippi. Red rice has camouflaged itself well.

Usually the red rice seed is shorter and wider than long-grain rice; therefore, some of the red rice seed can be removed by seed-processing equipment. But in the last few years, a long-grain red rice has appeared that cannot be removed by processing. This is the result of natural crossing that has occurred in the field.

It is difficult to recognize this type of red rice in the field because of similarity in height, hull color, and grain shape. Since it is the same species as desirable rice, chemical control of red rice in rice fields is difficult at this time. Research with selective grass herbicides indicates control may be possible by preventing seed-head production. Maleic Hydrazide has been used in early maturing rice to suppress red rice seed head formation if timed properly. Registration of Maleic Hydrazide is pending at this time.

❑ Select Seed Source Carefully

Red rice infestations occur primarily through planting contaminated seed and through combine contamination. If combines are not thoroughly cleaned after harvesting a red-rice-infested field, they can contaminate later-harvested, non-infested fields.

Be careful of seed sources to be sure they do not contain red rice. Most pure seed laws permit some red rice in rice seed; certified plantings are more restrictive. The Mississippi Seed Law allows up to nine red rice seed per pound of rice seed, but no red rice seed can be present in any class of certified seed.

Seed bought directly from farmers does not have to meet state regulations, so this seed could contain anything the farmer chooses to sell. Be sure to check your seed source and plant on fields that are free of red rice if possible.

Since most red rice shatters before harvest, almost all the seed produced remains in the field. This results in heavy red rice stands and reduced yields the following year. Red rice seed can remain dormant in the soil many years, making eradication difficult and requiring rotational crops to reduce infestations.

❑ Chemical and Cultural Control Practices

Management is the key to controlling red rice and reducing its competition with rice yields. These are some control measures that can reduce the red rice problem:

- ❖ Begin a combination of crop rotation with soybeans or sorghum (preferably two years soybean, one year rice).
- ❖ Control red rice plants in field borders.
- ❖ Remove any plants chemicals miss.

You must design the control program for 100 percent control. Control is almost impossible while a field is planted to rice.

Fall plowing of clay soils following rice harvest may allow a flush of rice seed germination; winter freezes will kill these seedlings. Early land preparation before planting the rotation crop may produce another red rice seed germination flush that herbicides, preplant cultivation, and the planting operation can kill.

Most Mississippi rice soils are clay with higher than normal organic matter content. Effective control in rotational crops for soil-applied herbicides requires from one to two times the normal herbicide rate. Also, a single soil herbicide application seldom provides season-long control, since red rice germination occurs throughout the summer. Most soil herbicides provide effective control for 2 to 3 months. Make postemergence herbicide applications as needed to control escaped plants.

❑ Chemical Control Programs Based on Three-Year Rotation

◆ Year 1-Soybeans (planted in rows wide enough to cultivate)

Preplant Incorporated: Treflan 2X, Dual II, or Frontier – Tank mix these chemicals with Sencor/Lexone to improve the control of red rice and broadleaf weeds. (You can suppress red rice on clay and silt loam soils with Lasso.)

Postemergence: Multiple applications necessary

Postdirected: Paraquat + nonionic surfactant two applications – when soybeans are at least 8 inches tall. Make first applications before red rice is 3 inches tall, followed by second application 7 to 10 days later.

Over-the-top applications: (semi-direct to obtain maximum coverage of red rice seedlings in the soybean drill)

1. Assure II + nonionic surfactant or crop oil concentrate. Apply to red rice up to 4 inches tall. Repeat application to newly emerged plants when needed. Do not use vegetable (crop origin) oils as spray adjuvants or carrier with Assure II.
2. Select + crop oil concentrate. Apply to red rice up to 3 inches tall. Repeat application to newly emerged plants when needed.

Seedhead Suppression of Red Rice in Soybeans: Select + crop oil concentrate applied from 4-inch joint movement until early booting when you detect first swelling in the flag leaf sheath. Repeat application when needed. See state label for specific and limiting application instructions.

In situations with severe red rice infestations, transgenic technology is increasing the effectiveness of red rice control. Roundup or Liberty tolerant soybean provides an effective control program with non-selective herbicides.

◆ Year 2-Soybeans

Preplant Incorporated: Dual in tank-mix with Sencor/Lexone improves the control of red rice and broadleaf weeds. You will have some suppression of red rice on clay and silt loam soils with Lasso.

Postemergence: Same as Year 1

Following are further control measures in soybeans to be used in conjunction with PPI and multiple postemergence applications:

1. Mechanical Cultivation - multiple shallow tillage operations in early spring or fall. Using a smoothing device in conjunction with a tillage tool further stimulates red rice germination.
2. Prevention - clean all machinery when moving from infested to noninfested fields.
3. Hand Rogue - remove the entire red rice plant. Parts of the rice plant not removed can still produce viable seed.

◆ Year 3-Rice

For better red rice control, rice can be water seeded using the pinpoint seeding method. If you use this method, refer to the water seeding section of this publication for instructions.
Further control measures in rice include the following:

1. Mechanical Cultivation - same as soybeans.
2. Prevention - clean all machinery; purchase red rice free planting seed; when land leveling, avoid moving soil from red rice infested to non-infested areas; avoid using drainage ditches that may contain red rice.
3. Hand Rogue - remove the entire red rice plant. Parts of the rice plant not removed can still produce viable seed.

◆ Grain Sorghum as Rotational Crop

You can use grain sorghum as the rotational crop for the first year of the two-year rotation. Purchase seed that are treated with Concep or Screen and incorporate either Dual or Lasso before planting. Apply Atrazine either preemergence or early postemergence. You can then use Paraquat once or twice as a postdirected spray to control escaped plants, beginning when sorghum is 12 inches tall. If you plant grain sorghum the second year of the rotation, you cannot use Atrazine because of its residual label restriction.

◆ Rice Insect Management

Several insects are found in rice fields; some cause economic damage. In Mississippi, rice water weevil and rice stink bug are the primary insect pests. Chinch bug, fall armyworm, and grasshopper may cause damage but are usually in localized areas. You should implement control measures only when the infestation level is enough to cause economical losses. The primary insects and control measures are discussed below.

❑ Rice Water Weevil

Rice water weevils occur throughout Mississippi's rice-growing area. Fields in rice production for several years usually experience larger populations than fields recently brought into production. The adults are grayish brown, broad-nosed insects about $^{1}/_{8}$ inch long.

Adults overwinter in grasses and ground trash near rice fields. They are strong fliers and migrate into rice fields in the spring. Adult weevils may be found in rice before flooding but usually invade fields in large numbers soon after flooding. If the field is flushed, water weevils may be attracted into the field before a permanent flood is established. More weevil activity will occur in areas with open water, such as around levees and areas of thin stands. Higher populations are usually found in fields flooded during late May through mid-June.

Adult weevils feed on the leaves of rice plants. They remove portions of the upper leaf surface, resulting in a feeding scar. These feeding scars are about the width of a pencil line and range in size from 0.5 inch to 2 inches long. They are usually parallel with the midvein of the leaf. These scars usually are white but may be tan or brown. Under windy conditions, the thin layer of tissue in the scar may break loose and leave a hole in the leaf. The adult leaf feeding does not seriously damage rice plants but does indicate whether or not adult weevils are present. The adults lay eggs on young plants after they move into a field of rice. The eggs hatch and the larvae move down the plants to the root system. The larvae feed on the root system until they pupate. The larval stage of rice water weevils can seriously injure rice plants. Larvae or root maggots, as they are commonly called, feed on the roots and cause injury by pruning the root system. They are white, legless, and $^{1}/_{4}$ inch long or smaller. Larvae feed on roots for about 3 weeks after hatching. They spend about 2 weeks in the pupa stage before emerging as adults.

To determine if an insecticide treatment is needed, inspect the field. Start checking fields within the first few days after flooding. Rice fields with a history of water weevil infestations are more likely to require treatment than those that have not experienced damaging populations in previous seasons. The most likely place for adults to appear first is in areas where water is deep and stands are sparse, exposing open water. Populations will occur at a higher level around open areas and levee ditches than in thicker stands in bay areas. Check these areas for signs of adult feeding. However, do not base a decision to treat on weevil counts found only in such areas, because they may not be representative of the infestation level in the other more normal plant population areas of the field. Check six or more locations that are representative of rice plant populations. Correct timing of the insecticide application is necessary for acceptable control. Adult threshold levels are difficult to determine. As a rule of thumb, if you find an average of one adult per stop in 10 stops, treat the field. Currently, Karate Z and Dimilin are the only insecticides labeled for adult water weevil control, although other insecticides are being evaluated. Normally, treat the fields within the first 7 days after establishment of the permanent flood. Generally, one application of insecticide has provided effective control. A second application may be needed in areas with severe water weevil populations.

Fipronil (Icon®) seed treatment was approved in 1998 for water weevil control. Icon must be applied to the seed by a certified seed dealer; thus the decision to treat must be made early in the year to provide time for seed treatment. Icon effectively controls rice water weevils.

❑ Rice Stink Bug

The adult rice stink bug is light brown and shield-shaped. It spends the winter in clumps of grass and other ground litter before emerging in the spring to feed on grasses. The adult migrates to rice soon after rice begins to head. There it feeds and deposits eggs. Both the adults and the developing young feed by sucking juice from the developing kernels. Feeding on the milk stage of rice produces blank grains. Feeding on the soft dough stage can cause peckiness of the grains, although peckiness can be caused by factors other than stink bug feeding. Start checking the rice fields when rice is about 10% headed. You should sample four to six locations. Sampling should be done with a sweep net, making 10 sweeps in 180° arcs in front and to the sides of the person doing the sampling. The sweep net should be handled in such a manner that the open mouth of the net makes contact with the heads of the rice plants to capture any insects on the rice head in the net. Scout fields at least once a week until rice heads are mature.

When you find an average of 3 stink bugs in 10 sweeps during the first 2 weeks of heading, treat the area or the field. When you check the field later, after the field is completely headed and most of the heads are in the milk stage, treat when you find an average of 5 stink bugs in 10 sweeps.

❑ Fall Armyworm

Occasional outbreaks of fall armyworms occur in rice fields. These insects feed primarily on leaves and stems of unflooded rice. These insects may move out of adjacent wheat fields and grassy areas into fields that have seedling rice plants. Submerging the crop with water usually provides an effective control. However, if the rice plants are too young to be flooded, you should use an insecticide. These insects occasionally occur in headed rice and if left uncontrolled will cause substantial yield losses. Treat when you find an average of 5 or more worms per 10 sweeps.

❑ Grasshopper

Several species of grasshoppers may be found in rice fields. Green grasshoppers from the longhorn species usually feed on the flower parts of the plants. The brown species feed on leaves and the sides of stems of rice plants. Injured plants will sometimes produce white heads.

Grasshoppers are very seldom an economic problem in rice fields. However, during drought conditions, large numbers may move into fields as food plants surrounding the fields desiccate. In most situations, only border treatment is necessary to control a damaging population. Use the same sampling technique (sweep net) discussed in the paragraph for stink bug sampling to determine if an insecticide treatment is needed.

❑ Chinch Bug

Chinch bugs will occasionally attack seedling rice. Check rice frequently the first 3 weeks after emergence. The first instar nymphs are orange and about $^{1}/_{16}$" long. As chinch bugs mature through instars, they become black with conspicuous wing pods. They feed primarily on the rice stems just below the surface of the soil. The feeding of this insect causes the plants to wither and die. Flooding effectively controls the pest.

Insecticides may also be used to control chinch bugs. Since these insects are most active late in the day and at night, apply insecticides very early in the morning or late in the day for best results.

❑ Cattail Billbug

A condition known as whitehead sometimes occurs in rice because of feeding by cattail billbugs. In Mississippi, this problem has not been severe enough to cause serious economic loss; however, it is severe on rice levees. Dry soil around field perimeters will also cause the whitehead condition.

RICE INSECT CONTROL TABLE

Insect	Insecticide[1]	Pounds Active/A[2]	Threshold
Rice water weevil adult	Lambda-cyhalothrin (Karate Z)	0.025-0.04	Average of one per stop in 10 stops
	Diflubenzuron (Dimilin)	0.18-0.25	
Rice stink bug (All insect growth stages)	carbaryl (Sevin)	1 lb.	Early - 3 stink bugs/10 sweeps
	Lambda-cyhalothrin (Karate Z)	0.025-0.04	Later - 5 stink bugs/10 sweeps
	malathion	$^{1}/_{2}$ lb.	
	methyl parathion	$^{1}/_{4}$ lb.	
Grasshopper	carbaryl (Sevin)	1 lb.	Early - 3 grasshoppers/10 sweeps
	Lambda-cyhalothrin (Karate Z)	0.025-0.04	
	malathion	$^{1}/_{2}$ lb.	Later - 5 grasshoppers/10 sweeps
	methyl parathion	$^{1}/_{4}$ lb.	
Large grasshoppers	methyl parathion	$^{1}/_{2}$ lb.	
Fall armyworms	carbaryl (Sevin)	1 lb.	Control when finding 5 or more worms/10 sweeps[3]
	Lambda-cyhalothrin (Karate Z)	0.025-0.04	
	malathion	1 lb.	
	methyl parathion	$^{3}/_{4}$ lb.	
Chinchbug	carbaryl (Sevin)	1 lb.	Control when stand is being destroyed.[3] (Flooding effectively controls this pest)
	Lambda-cyhalothrin (Karate Z)	0.025-0.04	
	malathion	$^{1}/_{2}$ lb.	
	methyl parathion	$^{1}/_{4}$ lb.	

[1]Insecticides are listed alphabetically and not in order of their effectiveness.
[2]The recommended rates of active ingredients are the minimum rates that will control adequately when you follow control recommendations.
[3]Before beginning chemical controls, read the section on rice insects.

Restrictions:

Read the labels on all pesticides and observe all restrictions and precautions.

Carbaryl (Sevin): Do not apply within 14 days of harvest. To avoid plant injury, do not apply before heading if you have applied Propanil or will apply Propanil.

Dimilin: Do not apply within 80 days of harvest.

Karate Z: Do not apply within 21 days of harvest.

Malathion: Do not apply within 7 days of harvest.

Methyl Parathion: Do not apply within 15 days of harvest.

◆ Diseases and Controls

Rice diseases are influenced by varietal susceptibility, seeding rate, environmental conditions, and intensity and frequency of rice culture within a given area. You can control certain diseases by using resistant varieties, seed treatment, and better cultural and management practices. Diseases can cause substantial losses in yield as well as quality. All commercial varieties have some resistance to certain diseases. When a troublesome disease persists, you should use a variety with higher resistance if available. The following table gives disease reactions of several varieties.

Varietal Disease Reactions

Variety	Blast	Sheath Blight	Kernel Smut	Straighthead	Brown leaf spot	Narrow brown leaf spot	Leaf smut	Stem rot	Lodging	Plant type
Cypress	MR	VS	S	MR	MS-S	VS	S	MS	MR	SDF
Drew	R	MS	MS	MR	R	MS	MS	MS	MR-MS	INT
Jackson	MR-MS	MS	MS-S	MR	MS	MR	--	MS	MR	INT
Jefferson	S	S	--	--	--	--	--	--	R	SDF
Katy	R	MS	R	S	MS	MR	--	MS	MR-S	INT
Kaybonnet	R	MS	MR	MS	MS	MR	--	MS	MR-MS	INT
LaGrue	S	MS	S	MS	--	--	--	--	MR-S	INT
Lemont	MR	VS	R	MR	MS-S	S	S	MS	R	SDF
Litton	MR	MS	MS-S	MR	--	--	--	--	R	SDF
Madison	R	VS	MR	--	MR	MR	R	--	R	SDF
Cocodrie	MS-S	VS	VS	--	MR	MR	R	--	MR	SDF
Newbonnet	S	MS	S	MR	MS	MS	MS	MS	MR	INT
Priscilla	MR	MS	MS	--	MS	--	--	--	R	SDF
Rexmont	MS-S	VS	MR-MS	MR	R	MR-MS	--	MS	MR	SDF
Wells	S	MS	MR	-	R	-	-	MS	MR	INT

Abbreviations: R=resistant; MR=moderately resistant; MS=moderately susceptible; S=susceptible; VS=very susceptible; SDF-semi-dwarf; INT=intermediate

You can effectively reduce losses caused by rice diseases by following these general control practices:

1. Avoid undue stressing of rice plants during the growing season. (Drought, fertilizer, chemical stress, and others).
2. Apply recommended rates of nitrogen and other crop nutrient fertilizers at the proper time for the variety grown.
3. Use foliar fungicides if they are available to aid in control of specific diseases.
4. Use a crop rotation that will retard a build-up of disease organisms.
5. Plant the recommended seeding rate per acre.
6. Plant during recommended planting dates on a well prepared seedbed.
7. Use high quality seed treated with an effective fungicide.
8. Use varieties with the greatest resistance to diseases most prevalent in an area.
9. Control weeds and grasses early.
10. Destroy previous crop stubble as soon as possible.
11. If possible do not plant a blast susceptible variety on fields with light soils.

Fungicide Seed Treatments

Seed rice should be treated with a fungicide to prevent seedling diseases and to reduce certain seed-borne organisms. These fungicides are effective:

Company Name	Product Name	Rate	At Planting Treatment Allowed
Amvac Chem. Corp.	PCNB 2-E	5.45-8.9 oz/100#	NO
	PCNB 2LF	5.25-10.5 oz/100#	NO
Gustafson, Inc.	Arpon-FL	0.75-1.5 oz/cwt.	NO
	Apron-Terraclor Dust	2.4 oz/cwt.	YES
	Prevail Apron/Terra-clor/Vitavax	2-4 oz/bu	YES
	RTU-Vitavax-Thiram	5.0-6.8 oz/100#	YES
	42-S Thiram	1.5 oz/bu	NO
Setre Chemical Co.	System 3	2.0-4.0 oz/100#	YES
	Vitavax-CT Flowable	9.0-12.0 oz/100#	YES
Wilbur-Ellis	Apron Flowable	0.75-1.50 oz/100#	NO
	Apron TL	2.0-4.0 oz/100#	NO
	Nu-Gro PCNB Flowable	5.25-10.5 oz/100#	NO
Agtrol Chemical	Champion Seed Dressing	4.0-8.0 oz/100#	NO
	Champ Flowable	4.0-8.0 oz/100#	NO
	Champ Formula Flowable	2.0-4.0 oz/100#	NO
Ciba Crop Protection	Apron 25W	1.0-4.0 oz/100#	NO
	Apron 50W	0.5-2.0 oz/100#	NO
DuPont	Manzate 200/200DF	2.0-4.0 oz/100#	NO
Rohm & Hass Co.	Dithane F-45	3.2-6.4 oz/100#	NO
	Dithane DF	2.1-4.3 oz/100#	NO
	Dithane M-45	2.0-4.0 oz/100#	NO
	Dithane WSP	2.0-4.0 oz/100#	NO

Read label and use suggested seed treatment fungicides according to directions.

❑ Rice Diseases in Mississippi: A Guide to Identification

Rice is attacked by a number of diseases. Although some diseases are of minor importance, others cause serious economic damage.

Diseases have become more important in rice production for several reasons: expanded rice acreage in Mississippi, prolonged recropping of rice in certain areas and fields, and the limited availability of new land for long rotations. Soilborne diseases, such as sheath blight, build up when fields are frequently cropped to rice. Furthermore, rice grows in an aquatic system, resulting in a humid microclimate that favors disease development.

The recent release and adoption of short-statured, high-yielding varieties (semidwarfs) that respond to high rates of nitrogen fertilizer have also contributed to disease increases. Unfortunately, high nitrogen fertility not only increases yield but also increases susceptibility of rice to certain serious diseases.

Growers generally invest more money to produce a crop with new varieties and are, therefore, concerned about diseases that can cause partial or severe crop failure.

Proper identification of diseases is the first step in rice disease management. Some diseases can be managed by simply changing or adopting new cultural practices or by selecting a resistant variety. Situations may occur, however, that require the use of fungicide treatment, a costly control measure for a field crop such as rice.

❑ Correct Diagnosis Is Important

Correct disease diagnosis is essential for both the economic justification for treatment and for protection against crop failure. Before beginning treatment, make sure the disease is a damaging one and not a minor disease. It is also important not to ignore a serious disease because it was misidentified as a minor one.

You can identify most rice diseases by their symptoms. This guide provides accurate descriptions of rice diseases that occur or may occur in Mississippi. Key characteristics that distinguish a particular disease from another are provided with pictures included. The relative seriousness of each disease and its likely impact, along with factors that contribute to the prevalence of a disease, are outlined. This publication is not a disease control guide, although general disease management strategies are discussed. It is prepared for growers, consultants, industry field representatives, and other crop advisors who identify diseases in rice fields.

Disease control methods, such as resistant varieties and fungicides, change with time and should be constantly updated. Contact your county agent for the latest management techniques for a given disease.

Certain factors may occasionally cause disease symptoms to vary and, therefore, make diagnosis based upon symptoms alone confusing. These factors include environmental conditions, varietal resistance or partial resistance, the stage of crop development, and normal aging of leaves and other plant parts. In these situations, microscopic observations may be necessary to confirm a diagnosis. Contact your county agent to help you prepare samples to send to the Extension Plant Pathology Diagnostic Laboratory, Mississippi State University. Some county offices have microscopes for such analysis.

Quick Guide for Identifying Rice Diseases

Part of Plant Affected	Disease	Potential for Damage	Symptoms
Seed and Seedlings			
drill- seeded	seed rot	moderate	Seedlings fail to emerge. Seed or germinated seed decay, often with white moldy growth.
	seedling blight	moderate to high	Seedlings with brown discoloration of growing point, leaf base, and/or roots. Affected seedlings are stunted, yellowed, then killed.
	southern blight	moderate	Seedlings with dark rot on base of plants, white moldy growth on lower plant. Tan to brown sclerotia near soil line may be present.
water- seeded	water mold	high	Ball of fungal strands surrounding seed under water. Copperbrown or green spot on soil surface surrounding seed when field is drained.
	seedling blight	moderate to high	Seedlings (1 to 4 inches tall) dying in flood or after flushing field.
leaf blades	leaf blast	high	Lesions vary from round or oval spots with a gray or white center surrounded by a reddish brown border to elongated spots with pointed ends having a gray to white dead center. Elongated lesions may have a bright yellow border, a narrow reddish-brown border, or both, with the outer margin being yellow.
	brown spot	low	Small, round, dark brown spots with a dull yellow margin enlarging to round spots with a gray center and a thick, dark brown border. Spots are usually observed on pale green rice plants growing under stress.
	narrow brown leaf spot	low to moderate	Long, narrow, reddish-brown lesions parallel to leaf veins, usually confined to the area between veins.
	leaf smut	low	Short, linear to elliptical black spots on both sides of leaves. Spots become numerous but remain separated and are often slightly raised. Occurs as rice approaches maturity.
	leaf scald	low	Zonate lesions beginning at the leaf tip or margin with alternating bands of tan to gray with reddish brown forming a chevron pattern.
	bacterial blight	low	Lesions begin as water-soaked stripes near the leaf tip or margin. As lesions enlarge, the affected areas die and turn white to gray and have a wavy margin. Active lesions maintain a water-soaked leading edge, and milky-colored droplets may appear during periods of high humidity.

leaf sheath and stem	stem rot	low to moderate	Small, black, linear lesions on lower leaf sheaths near the water line appear from tillering to internode movement. Later, they appear as uniform dark brown to black discoloration of leaf sheaths. Leaves of affected sheaths die and turn brown. Black blotches are noted on culm (stem) under rotted sheaths. Internodal areas of culm rot and break over. Numerous small, black sclerotia are visible within sheaths and stems at maturity or after.
	sheath blight	high	Gray-green, water-soaked spots appear on sheaths near water line from tillering to internode movement. Oval spots develop with a gray center and dark gray border. When dry, spots are tan to white with reddish-brown to brown borders. White, thread-like growth spreads over healthy sheaths and leaves, forming new lesions. Lesions commonly form a continuous pattern of wide, tan to gray, dead areas with narrow reddish-brown bands (snakeskin). Brown sclerotia are loosely attached to blighted plant parts.
	black sheath rot	low to moderate	Gray or brown spots confined to lower leaf sheaths appear during internode movement. Spots enlarge to cover entire leaf sheaths. Spots are gray with a dark gray or brown to black upper and lower border. Lower leaves of affected sheaths die and turn brown. Reddish- brown, thread-like growth is observed on culm under rotted sheaths. Black, pepper-like fruiting structures occur on rotted sheath during growing season.
	sheath spot	low	Spots on upper portion of leaf sheaths near the leaf blade, usually appearing midway in the rice canopy. Spots are oval with white to pale green centers and a thick, dark, reddish-brown border. Spots remain separated and do not progress extensively onto leaves.
	sheath rot	low	Reddish-brown discoloration of the flag leaf sheath with panicles emerging poorly. Panicle may be twisted, covered with a white powdery mass, and has florets with brown discoloration. Panicle may fail to emerge fully from boot, and grain may not fill.
	cercospora sheath spot	low	Reddish- or purple-brown, netlike spot on sheaths of lower leaves. Blades of affected leaves turn yellow and die.
	collar rot blast	high	Collar portion of flag leaf becomes brown. Flag leaf shrivels, dies, and may fall off.
panicles, florets, and grain	rotten neck blast	high	Brown discoloration of the panicle node and surrounding area; stem of panicle shrivels and breaks over; panicle turns white, and grain stops filling. Node area may become gray as fungus grows and produces spores.

panicle blast	high	Panicle branches and small branches holding florets with brown discoloration, later turning gray. Portions of branch above these lesions turn white, and grains stop filling.
brown spot	low	Dark brown to black spots on grain hulls often large enough to cover entire grain. Affected grain may be poorly filled and chalky.
kernel smut	moderate	Grain poorly filled and covered with and/or partially filled with a black, powdery mass that rubs off easily.
sheath blight	high	Panicle emerging from boot, fails to branch out, turns paper white with some brown discoloration, remains upright, and fails to fill grain.

❑ Seedling Diseases

Seedling diseases contribute to poor seedling emergence, uneven stands, and stand failure. Seedling disease is a broad term that includes seed and seedling decay (preemergence damping off), and seedling blight (post-emergence damping off). Several soilborne fungi cause damping off, including *Rhizoctonia solani*, *Fusarium* spp., *Cochliobolus miyabeanus*, and *Sclerotium rolfsii*. Water molds, including *Pythium* spp. and *Achlya* spp., also cause stand losses. Water molds are generally more severe in water-seeded rice; however, drill-seeded rice can also be affected.

Seedling diseases are generally a problem under two conditions: (1) when untreated seed are infected with disease organisms such as the one responsible for brown spot or (2) when rice is growing poorly and under stress.

Prolonged cool and wet conditions or unusually hot weather after planting may retard seed germination and seedling growth and favor seedling disease. Conditions that delay seedling emergence, such as poor seed quality, also increase seedling diseases.

◆ Seed Rot and Pre-emergence Damping Off

❖ Symptoms

Failure of seedlings to emerge is the most obvious symptom of seed rot and preemergence damping off. Examination may reveal a cottony growth of mycelium (mold) in and around seed coats and the emerging seedlings, indicating attack by water mold(s). The growing point or root of germinated seedlings has a dark brown discoloration or rot. The base of the leaf sheath and the roots of emerged seedlings have a similar dark brown or reddish-brown rot. Affected seedlings appear stunted and yellow and may soon wither and die (seedling blight).

Water molds are particularly severe in water-seeded rice culture. In states where fields are frequently water-seeded, it has become difficult to obtain adequately dense and uniform stands. Seed rot that is caused by the water molds *Pythium* and *Achlya*, and to a lesser extent the fungus *Fusarium*, have been identified as the cause of the problem. These fungi often act as a complex within affected fields. Symptoms of water mold can be observed through the flood water as balls of fungal strands radiating from seeds on the soil surface. When the flood is removed using the critical point method of water-seeding, affected seeds are surrounded by a mass of fungal strands. This results in circular, copper brown or dark green spots on the soil surface, about the size of a quarter, with the rotted seed at the center. The colors of the spots are the result of bacterial and algal growth. Seed rot by water molds is favored when the water temperature is unusually high or low. If seedlings are attacked after germination at pegging, seedlings become yellow and stunted and grow poorly.

◆ Seedling Blight

❖ Symptoms

Wet and warm conditions favor seedling blight caused by *Sclerotium rolfsii* (southern blight). In soil infested by the fungus, large areas of plants may be killed, often along rows. Symptoms include a dark-colored rot on the base of plants and a white moldy growth on lower plant parts. Small, round (less than $^{1}/_{16}$ of an inch in diameter), tan to brown sclerotia can be seen attached to roots and lower leaves near the soil surface. Immediate flooding of fields affected by southern blight will stop disease progress.

❖ Management

To manage seedling diseases, use both cultural and chemical methods:

- ❖ Correct low areas in fields that collect water.
- ❖ Seed treatment at the proper rate with a protective fungicide is essential to minimize seed rotting and seedling blight in either drill- or water-seeded rice.
- ❖ Plant rice when temperatures are adequate to maintain active rice growth (soil temperature greater than 60 °F, average air temperature of 65 °F).

❑ Foliage Diseases

◆ Blast

Blast is caused by the fungus *Pyricularia grisea* (formerly *Pyricularia oryzae*) and is one of the most damaging and, therefore, important rice diseases in Mississippi. Occurrence of blast is unpredictable because of yearly changes in weather, acreage planted to susceptible varieties, and the development of new races of the fungus that can attack varieties previously resistant.

Blast damages plants and reduces yield in a number of ways. Leaf spots or lesions reduce the effective leaf area. Lesions form on nodes of the stem and panicle, panicle branches, and the small panicle branches that support individual grains, causing girdling that results in incomplete grain fill or total grain failure. Losses in severely affected fields may exceed 50 percent.

❖ Symptoms

Symptoms of blast differ depending upon the part of the rice plant attacked. These phases of blast include leaf blast, nodal blast, collar rot, neck rot, and panicle blast.

Leaf blast occurs primarily in seedling and tillering stages of rice development. Plants under flood are generally resistant to leaf blast during internode elongation (jointing). Leaf spots are elliptical with pointed ends (elongated diamond-shaped). The centers of the spot are usually grayish or white with a brown or reddish-brown margin. The spots begin as watersoaked dots and rapidly expand to produce the typical leaf spot. Spots vary depending upon varietal susceptibility, environmental conditions, and age. On more resistant varieties, the spots are very small and rounded, with a thick brown margin. On highly susceptible varieties, spots are large (.4 to .6 inches long) and often have no dark margin but a yellow margin or halo surrounding the spot.

Plants grown under an adequate flood are generally more resistant to leaf blast than those grown where a flood is difficult to maintain or under dryland culture. Leaf blast in Mississippi is not considered a damaging phase of blast disease, although it is a convenient warning that blast will be a problem.

Nodal blast may occur but is not widespread in Mississippi. The stem (culm) nodes are affected and turn black, and the plant above the node soon dies. Infected mature nodes turn gray, shrivel, and often break over just above the node.

Collar rot : When the rice plants reach the reproductive stages, susceptibility to blast increases again. Collar rot occurs when the base of the flag leaf near the sheath is infected. The lesion will extend upward on the leaf and downward on the sheath around the point of attachment. The lesion is grayish colored, sometimes with a brown border. If the lesion girdles the flag leaf, the leaf shrivels and dies, turns brown, and may eventually fall off.

Rotten neck is infection of the uppermost node and/or panicle base, resulting in a girdling, dark lesion. With maturity, the panicle often breaks over at the lesion.

Panicle blast is infection of the primary and secondary grain branches and the small branches that support grain (pedicels) in a fashion similar to rotten neck. Depending upon the stage of grain fill at infection, portions of the grain head (with panicle blast) or the entire grain head (with rotten neck) will be white in contrast to green or tan color of healthy grain. This "blasted" appearance is caused by sterile or blank grain. Seed from infested fields are often contaminated with the blast fungus.

❖ Disease Cycle

Thousands of airborne spores are produced on lesions and are carried considerable distances by air currents. Spores land on leaves, germinate, penetrate the leaf, and cause a lesion 4 days later; more spores are produced in as little as 6 days.

Infections from spores arriving from a distance are termed primary infections. Primary infections generally result in a few widely scattered spots on leaves. Spores arising from the primary infections can cause many more infections. This cycling is called secondary spread. Secondary spread is responsible for the severe epidemics of blast in fields and localized areas.

Certain practices and conditions favor blast development. Blast has long been associated with rainy, cool, overcast weather. Optimum conditions for disease development are average daily temperature between 73 °F and 79 °F and prolonged leaf wetness and relative humidity greater than 90 percent. In the growing season in Mississippi, these conditions are generally present on rainy, overcast days.

Excessive nitrogen fertilizer results in excessive growth that is more susceptible to infection and results in rice that retains moisture, thus creating a favorable environment for disease development. Thick stands of rice will also retain excessive moisture. Blast is also more of a problem if rice is grown on a light-textured soil.

❖ Management

Failure to maintain an adequate flood greatly increases the occurrence and severity of blast. Often a blast epidemic in a field begins in a high area or an area where the flood has been lost. Growing rice on sandy soils or steep contours often makes it difficult to maintain a flood. The best way to control blast is to use resistant varieties. Integrate the use of resistant varieties with good cultural practices (proper field selection, seeding rate, fertilization, and flooding).

Treating seed with a fungicide provides insurance against seedborne blast. Plan a fungicide program when you grow a variety susceptible to blast. Timing and applications are critical. Consult your county agent for the latest information on blast control. Under conditions favorable for severe blast development, it is difficult for fungicides to control the disease on a susceptible variety, and you should expect some yield loss.

◆ Brown Spot

Brown spot, caused by the fungus *Cochliobolus miyabeanus* (formerly *Helminthosporium oryzae*), is a common disease in Mississippi. Brown spot may occur in rice from the seedling stage through maturity, but it is most severe at or near maturity. The disease occurs on leaves, leaf sheaths, panicle branches, glumes, and grain. Severe brown spot can be damaging. It is an indication of plant stress.

❖ Symptoms

Foliar symptoms consist of brown, circular to oval spots that range in size from minute dark spots to oval spots up to about $^1/_2$ inch in diameter. Smaller spots are reddish-brown to brown, while mature spots often have a gray center with a dark brown margin. Symptoms can occur anytime during the growing season from the seedling stage until maturity. Spots on seedlings may become numerous, join together, and cause seedling blight. Spots on leaf sheaths are similar to those on leaves. Dark brown to black spots appear on glumes and may be large enough to cover the glume surface. Brown spots may also appear on the grain.

Damage from brown spot on seedlings occurs through reduced stands (seedling blight) or weakened plants. Leaf spotting of older plants is not considered a damaging phase of the disease. However, severe brown spot on the panicle can reduce yield and grain quality.

❖ Disease Cycle

The brown spot fungus is normally present in areas with a long history of rice culture. The fungus survives on stubble and debris from previous rice crops and on seed. Airborne spores that can cause infection are produced in infested debris and older lesions.

❖ Management

The occurrence of excessive brown spot usually indicates unfavorable growing conditions or poor soil fertility. These unfavorable conditions include inadequate nitrogen fertility, cold water areas near wells, root pruning by the rice water weevil, and areas of poor soil resulting from land forming operations.

To manage brown spot, maintain proper fertility levels and/or correct the factors causing the plant stress and poor growth. Seed treatment with a fungicide will partially control brown spot on seedling rice, reducing both seedling blight and inoculum availability later in the season. Foliar fungicide applications are not recommended to control brown spot.

The occurrence and severity of brown spot have lessened in recent years because of the increased rates of nitrogen fertilization used with modern varieties.

◆ Narrow Brown Leaf Spot

This disease has not been a problem in Mississippi but potentially could be because it does occur at damaging levels in nearby states. Narrow brown leaf spot is caused by the fungus *Cercospora oryzae*. In areas where the disease routinely occurs, it varies in severity from year to year. Heavy damage usually occurs on the most susceptible varieties. Although the fungus attacks leaf sheaths, glumes, and occasionally nodes, it is most damaging as a leaf spot that reduces the effective leaf area. As with most foliar diseases, early infections have a greater potential to cause yield loss than late infections. Severe leaf spotting may cause premature leaf death, ripening, and occasionally lodging.

The fungus produces airborne spores and probably survives in fields on infested rice debris. The pathogen may be seedborne.

❖ Symptoms

Symptoms of narrow brown leaf spot on leaves and upper leaf sheaths include short, linear, brown spots. These lesions range in size from $^1/_8$ to $^1/_2$ inch long by $^1/_{16}$ to $^1/_8$ inch wide and are parallel to the leaf midrib. Lesions on resistant varieties are short and dark brown. Lesions on susceptible varieties are longer and have a gray center. Lesions become more numerous as the plant approaches maturity.

The fungus also causes a “net blotch” symptom on the lower leaf sheaths. Lesions are 1 to 2 inches long, reddish- or purple-brown, with a net-like appearance and may encircle the plant. Leaves of infected sheaths turn yellow and die.

❖ Management

There are apparent differences in varietal susceptibility to narrow brown leaf spot. This has resulted in considerable effort in breeding for resistance to this disease. However, resistant varieties generally become susceptible 3 to 5 years after release when new races of the fungus form and populations of the new race increase.

Several factors influence narrow brown leaf spot development: variety susceptiblity, prevalence of a race capable of attacking a variety, and the stage of rice development. Plants are susceptible at all stages but are most susceptible from heading until maturity.

Fungicides can reduce losses caused by this disease; however, unless the disease becomes severe in Mississippi, fungicides are not recommended. Contact your county Extension agent if you suspect narrow brown leaf spot.

◆ Leaf Smut

Leaf smut is a widespread but minor disease of rice leaves caused by the fungus *Entyloma oryzae*. The disease usually occurs in Mississippi late in the season near maturity.

❖ Symptoms

Symptoms of leaf smut are very small, short, linear, rectangular, or elliptical black spots on both sides of leaves. Numerous spots appear on leaves, but they remain separated. The spots (sori) are masses of black smut spores covered by the leaf epidermis. Spots may also develop on leaf sheaths and the culm (stem). Severely infected leaves turn yellow and may split or die at the tips. The leaf smut fungus overwinters on old diseased leaves in the field, which provide inoculum for infections the next summer. The disease is spread by airborne spores. Because leaf smut occurs late in the season and causes little or no yield loss, no control measures are recommended.

◆ Leaf Scald

Leaf scald was first reported in the United States in Louisiana in 1971. The disease occurs annually in that state. The disease is caused by the fungus *Gerlachia oryzae* (*Rhynchosporium oryzae*) and has been observed in Mississippi although the frequency and extent of occurrence are not known. The disease is of minor importance because the causal fungus primarily attacks leaves approaching maturity late in the season. The fungus is also reported to attack seedlings and panicles. The fungus is seedborne and survives on infested rice leaf debris. High levels of nitrogen fertilization favor leaf scald development.

❖ Symptoms

The primary symptoms of leaf scald are zonate lesions beginning at the leaf tip or edges of leaf blades. The lesions may have alternating light (tan) and dark (reddish-brown) areas that make a chevron pattern on affected leaves. The leading edge of the affected leaf is usually yellow, resulting in a gold appearance of severely affected fields. Affected leaves dry and appear straw- colored. Affected panicles exhibit dark, reddish-brown discoloration of entire florets and/or grain hulls.

Because the disease generally occurs late in the season and is not considered serious, no controls are recommended.

◆ Bacterial Panicle Blight

Bacterial blight has been found in Mississippi. The disease is caused by a bacterium, *Burkholderia glumae*. In Asia the disease is severe, with yield losses approaching 60 percent. The disease in the United States is caused by a mild strain of the bacterium.

❖ Symptoms

In temperate regions of the world, symptoms of bacterial blight appear first in the flag leaf at heading. Lesions begin at the margin of the leaf blade near the tip as water soaked stripes. The lesions enlarge in length and width, turn yellow, and have a wavy margin. The border of healthy and diseased leaf tissue retains a watersoaked appearance when the disease is still active. You may see milky or opaque water droplets on infected leaves when dew is present.

Blight lesions caused by severe strains of the bacterium elongate over the entire length of the flag leaf, giving a striped appearance to leaves. Lesions caused by the mild strain are usually only 1 to 2 inches long and rarely up to 7 inches long. As lesions age they become bleached white or tan and appear papery but later become grayish as saprophytic fungi grow on dead areas. Fields or areas in fields infested with bacterial blight have a white ragged appearance compared to uniformly green, healthy fields.

Panicles may be infected by the severe strain. Discolored spots with a water-soaked margin appear on glumes in contrast to healthy, green panicles.

Little is known about the origin of bacterial blight in the United States or how it overwinters. The bacterium is short-lived in soil but is suspected to be seedborne. However, it is also short-lived on seed and may not survive well in seed lots over the winter. Weeds are thought to be the primary source of bacterial blight in parts of Asia where bacterial blight occurs frequently. The disease spreads by wind-blown rain, and disease development is encouraged by rain and high humidity.

It appears that the mild strain found in the United States is spreading to new areas. Bacterial blight is a potentially dangerous disease that could flourish under Mississippi conditions. Producers should immediately contact their county Extension agent if bacterial blight is suspected. The disease can be quickly diagnosed under a microscope by observing bacteria streaming in the areas between diseased and healthy tissues on leaves.

❑ Stem and Leaf Sheath Diseases

◆ Stem Rot

Stem rot disease, caused by the fungus *Sclerotium oryzae*, is one of the most common diseases in Mississippi and in nearby rice-producing states. The disease is most severe in fields with a long history of rice culture. Yield losses from stem rot are difficult to assess. It causes rot of the leaf sheaths and stem, which can contribute to lodging. If the stem is rotted before grain fill, premature ripening and incomplete grain fill result. Although the disease routinely occurs in Mississippi, visible damage, if it occurs at all, is usually confined to small areas of infested fields.

❖ Symptoms

The first symptoms of stem rot appear near the water line as small, dark brown to black, linear lesions $^1/_8$ to $^1/_4$ of an inch long. Symptoms usually appear during internode movement stages of rice development. These lesions expand and appear later as black angular blotches on lower leaf sheaths.

The disease progresses to cause a uniform dark brown and black discoloration (rot) of lower leaf sheaths near maturity. Leaves of affected sheaths die, turn tan to brown, roll around the mid-rib, and may retain their position and integrity in the rice canopy. Small, scattered patches of white mycelium (mold) may appear on the surface of rotted sheaths. When rotted leaf sheaths are peeled back, the culm may exhibit the same angular black blotches.

In severe infections, internodal areas of the culm may have a general dark brown to black rot, giving a water-stained appearance to the lower areas of affected tillers. Rot of the culm increases in intensity as plants approach maturity. If culm rot is extensive, tillers break over between the nodes and lodge. Small black sclerotia (survival units) develop in sheaths and stems from the time of maturity to after harvest. The presence of numerous sclerotia in sheaths and stems of affected mature plants or in the stubble after harvest is an easy way to identify stem rot.

❖ Disease Cycle

The fungus overwinters and survives the absence of a rice crop for long periods as sclerotia in the upper layers (2 to 3 inches) of the soil profile. The half-life of sclerotia in the field is about 2 years. Viable sclerotia have been found in fields for up to 6 years after a rice crop. The sclerotia are buoyant and float to the surface of floodwater where they contact, germinate, and infect rice tillers near the water line.

❖ Management

Although no commercial varieties are highly resistant to stem rot, early maturing varieties are less prone to stem rot damage than later maturing varieties. Excessive nitrogen fertility, potassium deficiency in soil, and overly dense seeding rates encourage stem rot development. Stagnant water remaining at the same level in flooded rice fields also favors disease development.

Deep incorporation of infested crop residue or burning of stubble after harvest reduces the level of inoculum available for infection. On the other hand, shallow incorporation of infested stubble after harvest can increase stem rot incidence and severity.

Since complete control of stem rot is impossible, an integrated approach to management is suggested. Plant early maturing varieties instead of more susceptible late maturing varieties. Do not exceed recommended nitrogen levels or seeding rates for a given variety. Correct any potassium deficiencies according to soil test results. Stem rot damage is usually minimal with modern varieties, so it is doubtful you will see yield increases from water management and crop residue destruction programs.

Removal of the flood increases the risk of blast. The advantages of increased pumping to allow fluctuations in water level are probably offset by current concerns about excessive water use for rice production in the Mississippi Delta. Achieving a complete burn of rice stubble in this area is difficult at best. Moldboard plowing for deep burial of inoculum is probably not economical. Some fungicides used for sheath blight control suppress stem rot development. However, it is unlikely that use of fungicides targeted at stem rot alone will provide enough economic return to offset costs.

◆ Sheath Blight

Sheath blight caused by the fungus *Rhizoctonia solani* has become the most important rice disease in Mississippi. The disease is widespread, occurs yearly, and reduces yields and milling quality. The disease has become more prevalent and more severe since the seventies. A reason for the increased prevalence is the widespread planting of susceptible semidwarf varieties along with the high rates of nitrogen fertilizers used to produce high yields with these varieties. Increased rates of nitrogen have been shown to be correlated with increased plant susceptibility as well as making the environment within the rice canopy more favorable for disease development. *R. solani* causes numerous diseases of many crops. The strain that attacks rice also causes aerial blight of soybeans, primarily in south Mississippi.

❖ Symptoms

Sheath blight causes a blight of leaf sheaths, leaves, and panicles. Early infections also attack the culm (stem). Culms weakened by sheath blight are prone to lodging. The primary cause of yield loss results from a reduction of effective leaf area. This effect is most severe when the disease attacks the flag leaf before grain fill. Incomplete grain fill reduces total yield and results in lower head rice yields because the poorly filled grain breaks in milling.

Premature ripening associated with severe sheath blight also causes low moisture content in affected grain and makes it more susceptible to breakage during milling. Direct blighting of panicles by the fungus is thought to be a minor portion of potential yield loss.

Initial symptoms of sheath blight usually appear from late tillering through internode elongation stages of rice development. Spots appear on the leaf sheath near the water line. Spots are oval and range in size from $^{1}/_{4}$ to $^{3}/_{8}$ of an inch wide and $^{3}/_{8}$ to $1^{1}/_{2}$ inches long. The size and color of spots vary with environmental conditions.

Under humid conditions, the spots have a gray to grayish white center and a dark gray border. When the lower canopy is dry, spots have a white to tan papery center and a brownish border. Under humid conditions, white, web-like mycelium (mold) can be seen on the surface of spots and adjacent green areas. The appearance of white mycelium of the fungus, usually seen in the morning when dew is present, is an excellent way to distinguish sheath blight from other diseases that affect leaf sheaths.

The disease progresses from initial spots on the sheath as the mycelium of the fungus advances vertically and horizontally onto leaves of infected plants. Infection structures penetrate healthy sheath and leaf tissue from this superficial growth and cause new lesions. Rapid growth occurs during wet and humid conditions and ceases during dry periods. These intermittent periods of growth and infection cause an irregularly banded or "snakeskin" appearance to blighted areas, with each band representing a favorable period for infection. The center portions of these new lesions are gray to papery white with dark gray to brown borders.

The sheath blight fungus spreads to adjacent plants by contact of infected plants with uninfected plants and by growth of the fungus on the surface of floodwater. Under favorable conditions, the disease can progress to blight all the foliage, including the flag leaf. Panicle infections occur during early heading when the emerging head contacts adjacent diseased foliage. The head appears off-white and papery with dark brown blotches and fails to branch and/or produce any grain.

The fungus does not spread long distances, so infected plants are usually found in circular patterns of limited size. When tillers and plants in these circular areas die, they appear smoke or gray colored from a distance and may join together with other affected areas to form large areas of dead, dying, or lodged plants. These areas are often most apparent near the edges of fields where wind-blown debris accumulates during early permanent flood. Several grassy weeds, including broadleaf signalgrass, are also susceptible to sheath blight and exhibit typical symptoms.

❖ Disease Cycle

As lesions age, the mycelium begins to form white balls that turn tan then dark brown. They are small ($^{1}/_{16}$ to $^{1}/_{8}$ of an inch in diameter) rock-like structures called sclerotia. They are survival structures of the sheath blight fungus. On susceptible long-grain varieties, more than 50 may form on a single plant. Sclerotia are easily dislodged from plants during harvest and fall to the soil surface. Sclerotia in infested fields accumulate in the upper soil profile, providing sources of infection for subsequent rice crops. Sclerotia float to the surface of the permanent flood, where they contact tillers, germinate, and cause infections. Sclerotia can germinate up to eight times and infect plants each time. They can survive for several years in the absence of a rice crop, although their numbers decline with time.

The level of primary infection (initial spots on lower leaf sheath) depends on the concentration of sclerotia in the field. Infested fields that have short rotation intervals with other crops or with rice following rice will promote buildup of sclerotia. Further development of the disease, horizontally and vertically in the canopy, and the amount of damage incurred depend on several factors.

The compact and leafy stature of certain varieties often creates a more favorable environment for disease development than taller varieties with a more open canopy. The disease must also progress farther to reach the critical flag leaf on taller varieties. Excessive fertilization and seeding rates create a dense, lush canopy favorable for disease.

Weather also greatly influences sheath blight development. Infections occur under high relative humidity (greater than 90 percent) and at temperatures from 73 to 95 °F. Temperatures from 86 to 90 °F create the best conditions for infection. Disease progresses most rapidly from heading to maturity.

❖ Management

Control of sheath blight is difficult and must rely on an integrated management approach:

- ❖ Although no truly resistant varieties of the long-grain type are commercially available, choose the least susceptible variety based on current Extension recommendations for problem fields.
- ❖ Do not exceed recommended nitrogen or seeding rates for a given variety.
- ❖ Avoid alternate-year rice rotations if possible, and do not plant consecutive rice crops. Surveys show these rotations result in higher levels of sclerotia and sheath blight compared to rotations where rice is cropped every third year.
- ❖ Thoroughly scout fields to determine the incidence of sheath blight if you are considering the use of a fungicide.
- ❖ Consult your county Extension agent for the latest information on varieties and fungicides.

◆ Black Sheath Rot

Black sheath rot is caused by a fungus, *Gaeumannomyces graminis* var. *graminis*, which is closely related to the fungus that causes “take-all” disease of wheat. The disease was first discovered in the United States in Arkansas in 1923 and has been increasing in occurrence in Mississippi in recent years. The disease appears to be a minor one in the state thus far; however, Texas and Arkansas have reported severe lodging, reduced number of panicles, reduced grains per panicle, and less grain weight per panicle. The disease could reduce yield through premature ripening, incomplete grain fill, reduced tillering, and lodging.

❖ Symptoms

Symptoms of black sheath rot in Mississippi have first appeared as spots on lower leaf sheaths in the mid- to late joint elongation stages. The color of spots has varied, even on tillers of the same plant. Spots are $^{3}/_{4}$ to $1^{1}/_{2}$ inches long and about $^{3}/_{8}$ of an inch wide. They are gray or brown. The spots enlarge but remain confined to the leaf sheath. Discoloration may remain gray with a black or brown upper and lower border. When you peel back the rotted leaf sheath, you can see dark reddish-brown strands of the fungus (mycelium) on the inner surface of the leaf sheath.

When sheath rot becomes extensive, the attached leaf is killed, turns tan or light brown, and retains its position in the canopy. Observation of black, pepper-like fruiting structures of the fungus at some point in the discolored areas is an excellent way to distinguish this disease from other sheath diseases.

When black sheath rot is severe during heading, all the leaf sheaths except those of the flag leaves become infected and rot, and the attached leaves are killed. The general discoloration of the lower plant appears dark brown or black at this stage. When you pull back the sheaths, you may see black rings or “eyespots” on the internodes, and a dark brown or black rot of the nodes occurs.

Black fruiting structures of the fungus are numerous during heading in the sheath tissue. If lodging occurs, the stems break over at the nodes rather than between the nodes as with the stem rot disease. Although the dark fruiting structures resemble the sclerotia of the **stem rot** disease, they appear earlier with black sheath rot than with stem rot.

The disease appears different from sheath blight in that no white mycelium appears on or near affected areas, and leaves are not directly attacked.

❖ Management

Factors that favor black sheath rot development are not well defined. The disease in Mississippi occurs more frequently and severely on sandy soils than on heavy clay soils.

The comparative reactions of rice varieties to black sheath rot are not known, but the disease has been observed most frequently on the semidwarf variety "Lemont."

Since the disease appears to be of minor economic importance, no controls are recommended. Proper identification of this disease is critical because under certain conditions the disease resembles other diseases. Mistaking black sheath rot for sheath blight can be costly if you initiate a fungicide program.

◆ Sheath Spot

Sheath spot is caused by the fungus *Rhizoctonia oryzae*, which attacks leaf sheaths. Symptoms closely resemble early sheath blight infections. The disease does not develop extensively in the rice canopy and is not of economic importance.

❖ Symptoms

Spots or lesions usually appear on leaf sheaths midway up the tiller. Spots are oval, $^{3}/_{8}$ to $^{3}/_{4}$ of an inch long and $^{3}/_{16}$ to $^{3}/_{8}$ of an inch wide, usually occurring on the upper leaf sheath near the leaf blade. The spots have white to pale green centers with a broad dark reddish-brown border. These spots remain separated and do not progress extensively on the leaf blade. Usually the leaf base is the only part of the leaf blade that is attacked, along with a spot on the sheath.

Other characteristics of sheath spot that differ from sheath blight are the absence of fungal growth (mycelium) extending from spots over adjacent green areas, the absence of sclerotia near older infections, and the lack of continuous, extensive lesion development on leaves and tillers from initial infection. In Mississippi the disease often appears later in the season than sheath blight.

Fungicides targeted for sheath blight give little or no control for sheath spot. No controls are recommended for sheath spot.

◆ Sheath Rot

Sheath rot disease, caused by the fungus *Sarocladium oryzae*, usually occurs on the flag leaf sheath (boot) that encloses the panicle. The disease is generally of minor importance and scattered within fields, but occasionally areas within fields may develop sheath rot at a level that affects yield.

❖ Symptoms

The lesions first appear as oblong or irregular spots about $^{3}/_{16}$ to $^{5}/_{8}$ of an inch long with a gray center and a reddish-brown margin, or they may be completely reddish-brown. The latter symptom is common with United States long-grain varieties.

Lesions may also form an irregular target appearance. Lesions will enlarge and join to cover most of the sheath. If the sheath is infected before head emergence, the panicles may not emerge. If infection occurs during emergence, the panicle partially emerges. Abundant white powdery growth of the fungus is later observed inside affected leaf sheaths and on the surface of rotted panicles. Panicles of sheaths affected before emergence rot, turn brown or reddish brown, and fail to produce any grain.

Insect or mite damage to the boot increases the occurrence and damage of this disease. Most rice varieties are susceptible to sheath rot.

No control measures are recommended because of the minor importance of the disease.

◆ Dead Tiller Syndrome

"Dead Tiller Syndrome" was first observed recently in northeast Arkansas and has since been found in Mississippi. The cause has been identified as the fungus *Pythium arrhenomanes*. Symptoms develop 6 to 10 days after establishment of permanent flood.

Symptoms continue to develop for about 8 to14 days until the temperature of the flood water stabilizes, or symptoms continue throughout tillering where cold water is continually added to the field. Initial symptoms are the appearance of discolored tillers, with some wilting. Advanced symptoms include severe wilting of tillers, with some plants having yellow or orange leaf tips or margins.

Tiller death occurs rapidly after the onset of symptoms. Dead tillers initially retain their green color and then turn brown. Dead tillers become dislodged from plants and float on the water. When affected tillers are split, an internal rot can be seen beginning at a node. Symptomatic tillers generally have a well advanced decay and a foul odor. The main (oldest) tiller is usually affected and rolls up. The disease does not appear to spread from infected tillers to healthy tillers or plants.

The disease appears to be of minor importance in Mississippi, since only a small percentage of plants are affected. Furthermore, adjacent plants appear to compensate for any loss in tiller density. In Arkansas yield reductions have been observed in cold water areas as the disease progresses over a longer period of time. Most commercial rice varieties appear to be susceptible to dead tiller syndrome. No control measures are available.

❑ Panicle and Grain Diseases

◆ Kernel Smut

Kernel smut, caused by the fungus *Neovossia barclayana*, is a disease of increasing importance in Mississippi. Planting susceptible varieties and using high rates of nitrogen fertilizer have led to occasional economic losses. The disease does not cause a loss in total yield, but rice mills may dock or refuse shipments that contain a high incidence of smut.

❖ Symptoms

Symptoms of kernel smut are first noticed as the crop approaches maturity. Symptoms include black streaks or spots on grain. The black spores of the fungus replace a part or all of the infected rice grain. Under high moisture conditions, the spores swell and protrude from the hull and are visible as a black mass. The mass becomes powdery and is easily removed from infected grains by rubbing. Usually only one to five grains are affected per panicle; however, considerably higher levels of infection are possible. Milling of infected rice results in grain with a dull or gray appearance. Kernel smut is most important in rice that is sold for parboiling because partially filled, discolored grains break frequently in milling.

❖ Disease Cycle

Unlike smut diseases of other grain crops, kernel smut does not cause systemic infection of plants from seed transmission. The spores can overwinter in smutted kernels on the soil or be carried to fields on infested seed. The spores germinate the following year and produce many secondary spores as infected kernels float on floodwater or reside on the wet surface of levees. Spores are forced into the air and contact florets on developing panicles. If conditions are favorable during flowering (light showers, high humidity, temperatures from 77 to 86 °F), spores germinate and infect the florets. Infected florets then develop into smutted kernels.

The disease is favored by rank growth of rice under high nitrogen conditions. It is most severe on sandy loam soils and in high fertility areas of fields.

❖ Management

Neither seed treatments nor foliar-applied fungicides have been effective in reducing the incidence of kernel smut. Cultural practices such as crop rotation, proper fertilization, and use of smut-free seed can reduce levels of kernel smut. Varieties differ in susceptibility to the disease. Choose a resistant variety based on the latest information available from your county Extension agent regarding the reaction of rice varieties to diseases.

◆ Straighthead

Straighthead is a physiological disorder that results in panicle sterility. There is no known pathogen associated with the disorder. Straighthead occurs most frequently in rice planted in sandy soils with a high organic matter content or in soils with arsenic residues, usually resulting from application of MSMA to previous crops or from old cotton insecticides. Straighthead is of minor importance in Mississippi because most rice is planted on clay soils. Where it occurs, affected plants are usually localized within fields.

❖ Symptoms

Affected panicles remain upright instead of normally bending over as the grain fills. Panicles are completely or partially sterile. Typically the hulls are distorted to appear crescent or half-moon shaped. Severely affected plants may completely fail to head. Before heading, affected plants are often darker green than surrounding plants. Affected plants may also remain green at maturity.

❖ Management

Varieties vary in their reaction to straighthead. Plant resistant varieties in fields with a history of straighthead problems. Consult your county Extension agent for the latest varietal ratings for straighthead resistance. If you plant a susceptible variety, drain problem fields and dry two weeks after permanent flood is established to control straighthead.

◆ Grain Spotting and Pecky Rice

Many fungi and bacteria attack developing florets and grain, causing spots and discoloration on rice hulls and grain. Some of these fungi are pathogens that cause diseases in the field; others attack grain only under very favorable conditions. Damage by the rice stink bug, *Oebalus pugnax*, also results in kernel discoloration. Kernels discolored by microorganisms, rice stink bugs, or combinations of the two are commonly called pecky rice.

Pecky rice is a complex disorder that is intensified by insect feeding. Damage varies from slight discoloration to severely infected, lightweight kernels that are lost during harvesting operations. Affected kernels may be chalky and break during milling, thus reducing whole milling yield. Sound but discolored kernels may not be removed by milling, and their presence reduces grade.

Parboiling magnifies the disorder as the grain is strengthened and the discoloration intensified. Several factors in addition to insect feeding favor peck development: high moisture conditions during grain development, high winds during early heading, and the presence in the field of diseases that affect developing grain. Proper insect management will reduce this problem. Although use of fungicides to control pecky rice is not specifically recommended, use of fungicides targeted at other diseases also helps reduce this problem.

◆ Animal Pests

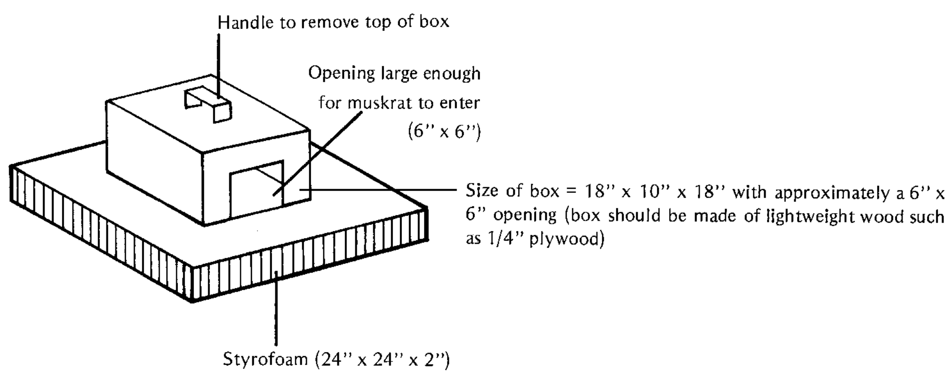
❑ Muskrats

Muskrats cause serious damage by foraging on rice stalks as well as by burrowing into levees. The burrowing causes loss of water control, which aggravates production problems. Muskrats use the rice stalks as food and as material for building dens.

The female muskrat can produce three to five litters per year. Litter size may vary from one to eleven, but five is the average. The gestation period is approximately 20 to 30 days. The breeding period is most active from October to April. Control measures taken during this season are effective in reducing breeding populations, since muskrats are more attracted to toxic baits during this time.

Muskrat control is more effective in winter for several reasons: (1) muskrat populations are more concentrated; (2) their natural food supply is limited; (3) they are easier to trap. Destroying their homes is the key to successful muskrat control. Drain water in flumes, ditches, and adjoining areas as low as possible. Also, destroying vegetation in the vicinity of water sources will aid in providing additional control.

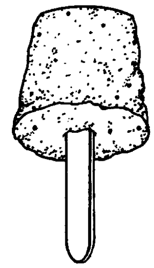
Toxic baits (anticoagulant baits) are effective, cheap, and safe to use. Use toxic baits primarily in winter. You can safely mix the anticoagulant bait with your hands, and it is more selective than other toxic materials. This type of bait depends on return feeding, which eliminates the possibility of bait shyness. Once the muskrat begins to feed on the bait, it will return nightly until it becomes sick and dies. One factor to remember when using anticoagulant baits is that you cannot put bait out one day and expect to see dead muskrats immediately. It is not easy to find dead muskrats because they will usually die in burrows and dens. Also, they must feed on the bait three or four times before they will get sick and die. If the anticoagulant bait works effectively, you will notice muskrat feeding for 3 to 7 days and then no further sign of feeding. At that point you can be reasonably sure the muskrat is dead. The effective use of toxic baits takes persistence, patience, and perseverance. The two most effective methods of using anticoagulant baits are the floating bait box and the stick bait. Both baits use a cereal grain base, with the stick bait having paraffin added to form the bait.



Wheat, corn, oats, etc. (crushed)	7 lbs
Vegetable oil (warm)	8 oz.
Anticoagulant concentrate (0.5% Pival)	1/2 lb

Combine and thoroughly mix dry grain and anticoagulant; then add oil and mix thoroughly in a container.

Stick Bait Recipe	
Wheat, corn, oats, etc. (crushed)	5 lbs
Paraffin	3 lbs
Anticoagulant concentrate (0.5% Pival)	1/2 lb



Combine the anticoagulant and crushed grain in a container and heat until it is uniformly warm. Heat the paraffin until it turns to liquid; let it cool slightly; then pour over the grain mixture. Stir the mixture thoroughly until all of the grain particles are coated. While the mixture is still warm, pour into paper cups, adding a wooden handle about 10 inches long. This mixture will fill approximately 25 nine-ounce paper cups. Once the stick baits cool, remove them from the cups.

Place stick baits near den entrances, slides, and other areas showing fresh muskrat activity. Check poison bait daily and resupply it if necessary.

Use trapping for more effective control during the growing season when muskrats are less attracted to baits. Several traps can be effectively used; however, the conibear trap, size 110, is probably the best because it catches the muskrat on the body. Place the traps in areas of apparent muskrat activity (slides, runs, burrow entrances, or around levee gates). Check and reset them daily for consistent and effective results.

Total eradication is usually impossible, but effective control can eliminate appreciable losses. Use control practices annually and encourage neighbors to join the control effort. For more information about muskrat control, consult your county agent.

❑ Blackbirds

During the rice seedling and ripening growth stages, blackbirds may cause extensive damage to rice. Usually the amount of damage to specific fields depends on favorable roosting sites near the field. Losses during the seedling stage generally are small, but severe losses may result during the ripening stage. The pests attack developing kernels in the milky stage and continue feeding until harvest is completed. The birds destroy more rice kernels than they eat. As the plant matures, blackbirds feed on rice heads and detached kernels that fall to the ground.

Although we know of no practical way to eliminate blackbird damage, most producers use frightening techniques that include one or a combination of these devices: (1) airplane; (2) air horns; (3) shotgun or rifle; (4) pyrotechnics; or (5) automatic gas exploders. In order for frightening techniques to be successful, start applications as soon as a few birds enter a field and carry out with persistence.

The key to satisfactory bird control is to prevent their establishing a flying habit into the fields. You can do this by frequent inspections and starting early control practices. Once blackbirds develop a flying and feeding behavioral pattern in fields, effective control becomes difficult.

Here are some more suggestions that may help in reducing damage from blackbirds:

1. Make sure the planted seeds are covered.
2. Flush the field to discourage blackbirds from pulling up sprouting rice.
3. Avoid very early or very late rice planting.
4. Harvest when rice is ready.